

and at Pleasanton, Nebr., on the 22d. Destructive thunderstorms occurred in Ohio on the 1st; in New Jersey on the 2d; in Minnesota, North Dakota, and Wisconsin on the 7th; in New York, Vermont, New Hampshire, Maine, Pennsylvania, Ohio, Indiana, Michigan, and Ontario on the 8th; in Tennessee on the 9th; in New Jersey the night of the 12-13th; in Minnesota, Indiana, and Maine on the 16th; in New Jersey, Pennsylvania, Maryland, and Illinois on the 17th; in North Carolina, Illinois, Missouri, and Iowa on the 18th; in Nebraska and Iowa on the 19th; in South Dakota and Iowa on the 20th; in Wyoming on the 21st; in Michigan on the 23d and 24th; in southeast Arizona on the 30th; and in New England, 31st.

Damaging drought prevailed generally in Kansas, Nebraska,

and Iowa, and in parts of South Dakota, Minnesota, Arkansas, Texas, Tennessee, Kentucky, Illinois, Indiana, Ohio, Michigan, New York, Massachusetts, Maryland, Virginia, North Carolina, South Carolina, and Alabama.

Navigation was suspended on account of low water on the upper Ohio River, and on the Cumberland River at Nashville; and the Arkansas River at Fort Smith, Ark., was lower than at any time since April, 1887.

Noteworthy auroral displays were observed at Sandusky, Ohio, the night of the 15-16th; at Huron and Rapid City, S. Dak., and Fort Buford, N. Dak., the night of the 16-17th; at Saint Vincent, Minn., the night of the 17-18th; and at Green Bay, Wis., the early morning of the 18th.

0 ATMOSPHERIC PRESSURE (expressed in inches and hundredths).

The distribution of mean atmospheric pressure for July, 1890, as determined from observations taken daily at 8 a. m. and 8 p. m. (75th meridian time), is shown on chart ii by isobars. The departure of the mean pressure for July, 1890, obtained from observations taken twice daily at the hours named, from that determined from hourly observations, varied at the stations named below, as follows:

Station.	Departure.	Station.	Departure.
Eastport, Me.	+ .006	Duluth, Minn.	— .000
Boston, Mass.	+ .009	Chicago, Ill.	— .000
New York City.	+ .011	Cincinnati, Ohio.	— .003
Philadelphia, Pa.	+ .005	Saint Louis, Mo.	— .006
Washington City.	+ .002	Galveston, Tex.	— .005
Savannah, Ga.	+ .005	Santa Fé, N. Mex.	— .006
Buffalo, N. Y.	+ .003	Denver, Colo.	— .005
Detroit, Mich.	+ .002	Salt Lake City, Utah.	— .008
New Orleans, La.	+ .004	San Francisco, Cal.	— .015
Saint Paul, Minn.	+ .001	San Diego, Cal.	— .015

The mean pressure was highest over the Atlantic coast states south of the 40th parallel, and along the Pacific coast north of the 40th parallel, where it was above 30.05, and the mean pressure was lowest from southern Nevada southward over southeast California and west Arizona, where it was below 29.80. In the British Possessions north of west Montana the mean pressure was below 29.85, and on the northeast slope of the Rocky Mountains, over the southeast part of the southern plateau region, and in the lower Saint Lawrence valley the mean readings were below 29.90.

A comparison of the pressure chart for July with that of the preceding month shows that there was an increase in pressure over the greater part of the interior of the country, and that there was a decrease in pressure at extreme northern lake stations and thence eastward over the lower Saint Lawrence valley, over the Gulf States and Tennessee, and along the Pacific coast south of the 45th parallel, and thence eastward over the northern plateau region and the western parts of the middle and southern plateau regions. The greatest increase in pressure occurred at Atlantic coast stations north of the 39th parallel, where it was more than .05, and the most marked decrease in pressure was noted over the northern plateau region, and at stations in the Sacramento and San Joaquin valleys, California, where it was .05.

The mean pressure was above the normal from the upper Mississippi and Red River of the North valleys eastward, in the south Atlantic states, the northern part of the west Gulf states and thence westward over the eastern part of the plateau region, and on the Pacific coast north of the 35th parallel, and thence eastward over the northern and the northwest parts of the middle plateau region. The mean pressure was below the normal from Montana and the Dakotas southeast over the Missouri Valley and Kansas, on the south Pacific coast and thence eastward over southern Nevada and Arizona, and from Alabama westward over the lower Mississippi valley and the

west Gulf states to the lower Rio Grande valley. The greatest departures above the normal pressure occurred along the Atlantic coast north of the 35th parallel, in the Saint Lawrence Valley, and at the more northern lower lake stations, where they exceeded .05. In districts where the mean pressure was below the normal the departures were less than .05.

6 BAROMETRIC RANGES.

The monthly barometric ranges at the several Signal Service stations are shown in the table of miscellaneous meteorological data. The general rule, to which the monthly barometric ranges over the United States are found to conform, is that they increase with the latitude and decrease slightly, though somewhat irregularly, with increasing longitude. In July, 1890, the monthly ranges were greatest in the lower valley of the Red River of the North and in extreme eastern Maine, where they exceeded .70, whence they decreased southward to less than .30 over extreme southern Florida and in the lower Rio Grande valley, southwestward to less than .30 over the east part of the southern plateau region and on the south Pacific coast, and westward to less than .30 on the coast of northern California, and to less than .40 in Washington and Oregon. Along the Atlantic coast the monthly ranges varied from .24 at Key West, Fla., to .79 at Eastport, Me.; between the 82d and 92d meridians, .36 at New Orleans, La., to .66 at Marquette and Alpena, Mich.; between the Mississippi River and the Rocky Mountains, .28 at Abilene, Tex., to .80 at Saint Vincent, Minn.; in the Rocky Mountain and plateau regions, .21 at Fort Grant, Ariz., to .58 at Fort Custer, Mont.; on the Pacific coast, .24 at Eureka, Cal., to .45 at Fort Canby, Wash. Chart ii shows that in July, 1890, there was a range in mean pressure of .31 from the south Atlantic coast to the southern plateau region; a range of .16 from the southern plateau region to the south Pacific coast; a range of .20 from the south Atlantic coast to the lower Saint Lawrence valley; and a range of .29 from the British Possessions north of Montana to the Pacific coast north of the 40th parallel.

6 HIGH PRESSURE AREAS.

Within the limits of the United States the paths of 5 high pressure areas were charted during the month of July. It is rather remarkable that these had nearly a steady motion from the west to the east and this was much more uniform than is ordinarily the case. The permanent high area of the Pacific coast had an important bearing upon the origin of at least 3 of these areas. The eastern portion of this high area rested upon the California coast throughout the month, and, as will be noted later on, there was a transference of offshoots from this to the plateau region and thence across the country. The table at the end of this description contains in concise form many of the characteristics of these high areas, and the following details are added:

I.—This had its origin to the north of the region of observation before the beginning of the month. Its general course was southeast, just to the south of Lake Michigan, until it

reached the Atlantic on the 6th. At the coast, the Sargossa Sea high area, as shown by the Bermuda observations, moved to the west on this date, and the union of the two had a slow movement to the southwest. All trace disappears on 9th in the central Gulf. A well-marked fall in temperature preceded this area until it reached the most southerly latitude of its course. There was a remarkable fall of rain at isolated stations in its centre when it reached the south Atlantic states. Over 4 inches in 24 hours fell at Quitman, Ga., and over 2 inches at one other station in Ga. and at one in S. C.

II.—This was first noted to the north of Montana and had a path and velocity almost exactly the same as the former, except that the motion to the southwest continued only a half day. This area appeared to merge in the south Atlantic area on the 12th. The fall in temperature was much more pronounced than in I, but unlike I there was no rain for some distance from the centre.

III.—This was an offshoot from the Pacific high area and moved very slowly the first 2 days. On the night of 13th there was a transference, without motion probably, to the north of Montana. The course was a little south of east until 16th, when all trace is lost over Lake Erie. The fall in temperature was quite irregular in front of this area and not well marked. It was due mostly to a radiation from the earth to the clear sky, and apparently was not produced to any marked degree by the advance of a cool wave in front. On 16th this area spread itself from Lake Superior to the Gulf, making a partial connection with the permanent area in the southeast, and the north portion disappeared as already indicated.

IV.—This area had the longest duration of any during the month. Entering the country at Oregon on 15th it disappeared off Nova Scotia on 23d. From first to last there was no rain within this area. The temperature changes in its front were quite insignificant.

V.—This was an offshoot from the Pacific area and passed into Oregon on 21st. All trace of it was lost in Colorado on 25th.

LOW PRESSURE AREAS OR STORMS.

The storms of this month have been very erratic in their movements, as has been noted in previous years. It is often impossible to trace a track with accuracy, owing to the slight diminution of pressure. The principal characteristic of these storms has been a rather marked tendency to remain stationary, or at times to even reform toward the west; it is hardly probable that these reformations were due to a backward movement. There has been a noteworthy tendency for these storms to pursue a course in high latitude, even north of the Great Lakes. The reason for this may have been the persistency of the high areas in moving towards the southeast and in uniting with the permanent Atlantic high area, as noted above. None of these storms have had very high winds accompanying them at any station of observation with the exception of III, which had a velocity of 75 miles on 7th, at Moorhead, Minn. The tracks of these storms, so far as they could be readily charted, will be found on chart I at the end of this REVIEW. The principal characteristics of the storms are given in the table at the end, and the following details are added:

I.—This storm was first noted to the north of Lake Michigan. It had a very slow motion down the Saint Lawrence Valley and disappeared in the Gulf of Saint Lawrence on the 5th. It had a slight intensity throughout its course, and had no marked rise in temperature in its front. The heaviest rain-fall in 12 hours accompanying was at Parkersburgh, W. Va., 1.80, 2d.

II.—This storm appeared to move south from N. W. T. on 3d. It was of short duration, being last noted on 6th in south Minnesota. The heaviest 12-hour rain was 0.44 at Fort Buford, N. Dak., 5th.

III.—On the day when II was last noted there was a trough of low pressure extending from south Minnesota to N. W. T., and in some respects this storm may be considered as having its origin in the former. The motion of this storm was due

east and its path was near the parallel of 50° throughout its course. There was a rise in temperature of 28° on the 7th and a maximum fall of rain of 1.58 in 12 hours at Qu'Appelle, N. W. T., on 6th.

IV.—For several days before the 8th the inclination of winds and a slight diminution in pressure indicated an atmospheric disturbance in the south plateau region. This disturbance culminated in a definite form on the evening of the 8th in south Idaho and moved with very slight intensity east and south, disappearing from view in Kansas on 11th. The heaviest rain in 12 hours was at Fort Elliott, Tex., 0.72, on 11th. No marked change in temperature was noted.

V.—On the morning of 12th a disturbance appeared north of Montana and this caused a secondary in the evening in South Dakota. This secondary was traced for 2 days, disappearing 14th in Illinois, though a trough-like depression still continued from Illinois to the Saint Lawrence Valley for another day. The heaviest rain in 12 hours fell in connection with a thunderstorm on the night of the disappearance, 2.08 at Keokuk, 14-15th. There was a rise of 30° in temperature in 24 hours.

VI.—Like V, this storm originated north of Montana where there was an atmospheric disturbance on the days near the 15th. This storm had the most rapid motion of any during the month, 42 miles per hour. Its path was nearly due east, and it disappeared off the New England coast on 17th. The heaviest rain in 12 hours was 1.38, at Atlantic City, N. J., the night of its disappearance. The greatest 24-hour rise in temperature occurred on 15th.

VII.—This storm had its rise to the north of Montana in a general disturbance on 18th. It had a slow motion to the southeast and disappeared in Louisiana on 24th. The heaviest rain was 0.85, at Leavenworth, Kans., on 21st.

VIII.—For 2 days before 23d there was a general disturbance to the north of Lake Superior from which this storm was separated. On evening of 23d a trough-like depression extended from where VII had just disappeared to the lakes, and this trough continued till evening 25th. The heaviest general rains of the month were reported in connection with this trough. At least 20 stations reported rain exceeding 1.50 in 24 hours in the south Atlantic and east Gulf states. The storm moved nearly east and was last seen at the mouth of the Saint Lawrence on 27th. No marked rise in temperature occurred. The Lawrence, Mass., tornado was connected with this storm.

IX.—This storm, like IV, took its origin in the general and quite permanent summer depression of the south plateau. Its progress was quite rapid in an east-northeast direction, disappearing from view on morning of 31st in Ontario. The heaviest rain in 12 hours was 1.58 at Rockliffe, Ont., on 31st. No marked rise in temperature occurred in its front.

On comparison with the storms of previous years it is found that, with one or two exceptions, they have originated either to the north of Montana or in the south plateau region and have almost invariably had a tendency to move in the higher latitudes, just as has been the case during this July. A short investigation has also been made in order to determine whether the velocity, intensity, or any other characteristic of high areas or storms may be connected in any way with the magnitude of the diurnal range of the barometer. The barograph curves at about 20 stations were examined for each day of the month and the magnitude of the diurnal range tabulated on a scale 0-3. It was found that the appearance of the curve changed greatly from day to day, especially at the northern stations. On charting these figures it was found that the magnitude of the diurnal range was uniform over very great areas, and these areas of equal magnitude had a slow motion toward the west or else remained nearly stationary. There was a slight tendency to an increase in the magnitude on the west side of high areas, but it cannot be said that there was any direct and marked connection between these phenomena.

In order to compare the relative velocity of high and low

by clouds and anticyclone

